# BASEWIDE ENERGY STUDY
# FORT WAINWRIGHT
# ALASKA

VOLUME 1
EXECUTIVE SUMMARY

PREPARED FOR
DEPARTMENT OF THE ARMY
ALASKA DISTRICT CORPS OF ENGINEERS
CONTRACT NO. DACA 85-80-C-0010

PREPARED BY
ENERGY CONSERVATION SERVICES
GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714



APRIL 1982

**DEPARTMENT OF THE ARMY**
CONSTRUCTION ENGINEERING RESEARCH [illegible] CORPS OF ENGINEERS
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CHAMPAIGN, ILLINOIS [illegible]

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# PREFACE

The final report of the Basewide Energy Study program consists of three volumes. The Executive Summary (Volume 1) highlights and summarizes the results of the study and concludes with an Energy Plan. The Technical Volume (Volume 2) includes the Executive Summary (serving as an introduction and summary), and also contains the technical discussion and justification of the recommended projects and plans. The Appendices (Volume 3) contains detailed calculations and supporting documentation.

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## Section 1
## INTRODUCTION AND SUMMARY

### 1.1 PURPOSE

In response to the Nation's commitment to energy conservation, the Army Corps of Engineers (CoE) has contracted with Grumman Aerospace Corporation to perform a Basewide Energy Study of three forts in Alaska. The purpose of the study is to produce a systematic plan of improvement projects to reduce energy consumption.

### 1.2 SCOPE

The contract (No. DACA 85-80-C-0010) includes studies at Fort Wainwright, Fort Greely, and Fort Richardson. Each fort is covered by a separate report.

This report covers Phases I and II of Increment A study of 104 buildings. Phase III was excluded from this contract. Increment B study was initially limited to the Steam Distribution System with subsequent addition of a heat/energy balance study of the Central Heat and Power Plant (CH&PP) and an Energy Monitoring and Control System (EMCS). Increment F & G studies were also added to the contract and are covered by this report.

In this Fort Wainwright report, current energy usage is analyzed and a set of energy conservation opportunities identified. These are defined, evaluated, and presented herein as a preliminary plan for increasing energy efficiency.

The report is divided into this Executive Summary, a technical volume, and an appendix volume.

The main feature of this report are the tables of recommended energy conservation actions. These actions are described in general in the technical volume of the report and the detailed engineering analysis supporting these conclusions can be found in Appendix A for

electrical system modifications, Appendix B for steam system modification, Appendices E and F for Central Heat and Power Plant analyses, and Appendix G for General Data.

## 1.3 DESCRIPTION

Fort Wainwright is an Army post located on the Chena River, adjacent to Fairbanks in the central valley of Alaska. It includes over 367 buildings with a total area of over 5.88 million gross square feet (GSF). Most of the buildings were built between 1941 and 1959. The Central Heat and Power Plant (CH&PP) generates 400 psig steam in coal-fired boilers that supply turbine generator sets. Extraction steam, currently at 70 psig, from the turbines supplies the fort with heating steam requirements through a below ground utility corridor (utilidor) distribution system. Electrical power required in excess of that supplied from extraction steam is from the condensing portion of the turbines, using cooling pond water for condenser cooling. The CH&PP provides electricity for this fort and also Fort Greely via the Golden Valley Electric Association (GVEA) utility transmission line. The map in Figure 1-1 shows the arrangment of buildings at the fort, grouped into heating zones used to aid in analysis during this study.

## 1.4 OVERVIEW

The following is a summary of the basic findings of this study, including energy conservation strategies leading to the energy conservation plan. Implementation of the recommended projects of that plan could reduce the net source energy consumption of Fort Wainwright by over 46% of the FY'80 Baseline consumption. The FY'84 projected cost of that FY'80 energy could be reduced by 46% or $2.5 million.

With the addition of a topping cycle at the CH&PP as discussed under Alternative No. 1 in 1.4.1 below, the savings would be 58% of energy and cost or $3.1 million in projected FY'84 dollars.

### 1.4.1 Central Heat and Power Plant (CH&PP)

The analysis of basewide energy usage shows that approximately 46% of coal input energy is consumed in the CH&PP. This establishes

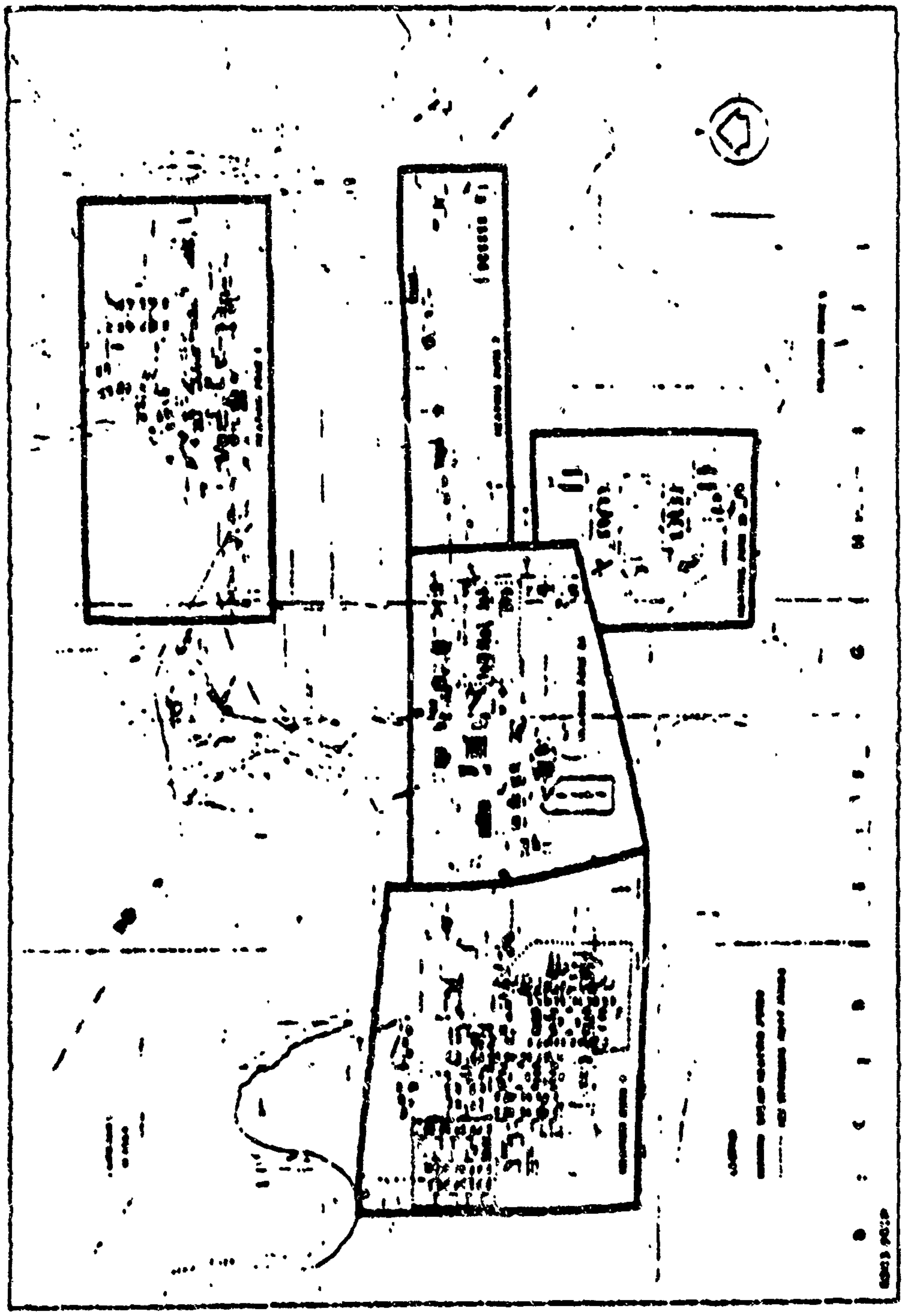

Fig. 1.1 Fort Wainwright Site Plan

study of the CH&PP as a most significant area for potential savings, since a small percent improvement can have a large impact.

A supplementary task to perform a CH&PP Energy Study of the Fort Wainwright CH&PP was added to a Basewide Energy Study of that Fort. The study objective was to identify changes required to achieve maximum plant efficiency based on heat balance studies. The plant is operated efficiently within the constraints of the existing equipment and power requirements. However, physical changes can be made to increase the operating efficiency.

Turbine performance basically defines the plant's performance. Power generated by extraction steam distributed to the Fort is produced efficiently in a cogeneration mode at a heat rate of around 5,000 BTU/KWH. Power generated by condensing exhaust steam, however, is produced at a heat rate approaching 25,000 BTU/KWH, and represents a basic inefficiency because of heat lost to the cooling pond. Reduction of this loss is a primary objective.

There are two alternative paths to maximum efficiency in the CH&PP, assuming the long term continuation of the current plant power production requirements.

<u>Alternative No. 1</u> - The most efficient alternative would be to install a topping cycle with a high pressure boiler generating steam for a 1,000 psig non-condensing turbine generator set of about 3 MW capacity that will exhaust into the existing 400 psig header in parallel with existing boilers.

<u>Alternative No. 2</u> - Assuming that Alternative No. 1 is not found acceptable for policy reasons, the existing plant can be made more efficient by an alternative set of modifications, most of which would not be cost effective if Alternative No. 1 were chosen. The major proposed modifications are as follows:

- o Install variable speed flow control for ID/FD fans. These fans operate at an inefficient point on the fan curves and a large reduction in energy is feasible
- o Install automatic boiler combustion controls

- Improve condenser performance by installing automatic tube cleaning systems in condensers, sharing condenser heat load between operating turbines, and increasing cooling water flow from pond to condensers.

Since considerations beyond the scope of this contract should enter into a decision on Alternative No. 1; such as regional electrical source planning, or plans for the interrelated Fort Greely CH&PP; the topping cycle option has been entered as an Increment G item. Alternative No. 2 is entered in the basic plan as an Increment B item.

1.4.2 Steam Distribution System

Associated with the steam distribution system is the loss of approximately 15% of source energy consumed on the site. In conjunction with conduction losses through the designed insulation of the distribution system are additional losses through uninsulated and minimally insulated piping, steam tracer lines that are on when not needed, and inefficient steam ejectors used for sewage pumping. In the summer, at base load, losses far exceed any steam user requirements, significantly reducing annual system efficiency. Means for reducing distribution losses are primarily increased insulation and automatic tracer line controls.

1.4.3 Buildings/Other End Users

Buildings and other end users account for approximately 37% of the source energy used on-site. Building envelopes are, in general, well insulated with the major exception of basements and floor slab edges. Despite storm windows, insulation, and improved heating controls, energy consumption is higher than would be predicted by conventional building thermal analysis. Much of this higher consumption is attributed to an overheating problem along with excess infiltration through windows that are opened to correct the overheating. Once the window is opened, it tends to remain open even when outside temperature drops. This occurs because local heating controls react to maintain comfort in the space and no incentive is taken on the part of the occupant to close the window. The corrective strategy is

to minimize the overheating problem and attempt to keep the windows shut while heat in the building is on. Overheating comes from various combinations and several sources such as:

- Supply temperatures set too high in air handling systems
- Radiation from radiators without controls or with control failure
- Radiation from building steam and hot water distribution systems
- Radiation from uninsulated components in mechanial rooms.

These heating energy inputs are superimposed on basic "natural" heat loads from people, solar, and electrical components which add up, in many buildings, to a requirement for cooling rather than heating for almost 50% of the year. Corrections by additional piping insulation along with additional control modifications are discussed in the recommendations.

Ventilation systems are another area where large savings opportunities exist. There is evidence of excessive outside air volume, especially if variable occupancy of the facilities is considered. There is also evidence of simultaneous heating and cooling, as well as the overheating problem mentioned earlier. Solutions vary from control resets to system modification or replacement. Fan speed reductions and fan speed cycles offer valuable electrical savings as well as steam savings.

Improvements in lighting efficiency are feasible and reduction of head bolt heater usage by modulation with temperature control can lower electrical requirements.

## Section 2
## CURRENT ENERGY USAGE

### 2.1 ENERGY USAGE HISTORY

Progress from FY'75 to FY'80 is shown in Figure 2-1 as a function of total annual Fort Wainwright coal consumption. In order to focus on Fort Wainwright energy performance it was necessary to subtract electrical energy exported to the Golden Valley Electric Association (GVEA) from the total annual electrical energy produced. From FY'75 to FY'80 the net Fort Wainwright reduction in coal consumption was 28% overall. The heating reduction was 19.5% with a corresponding coal reduction. Of the coal apportioned to Fort Wainwright electrical energy production (shaded portion of Fig. 2-1) there was a 46% reduction. This was the result of a '5.9% reduction in net KWH of

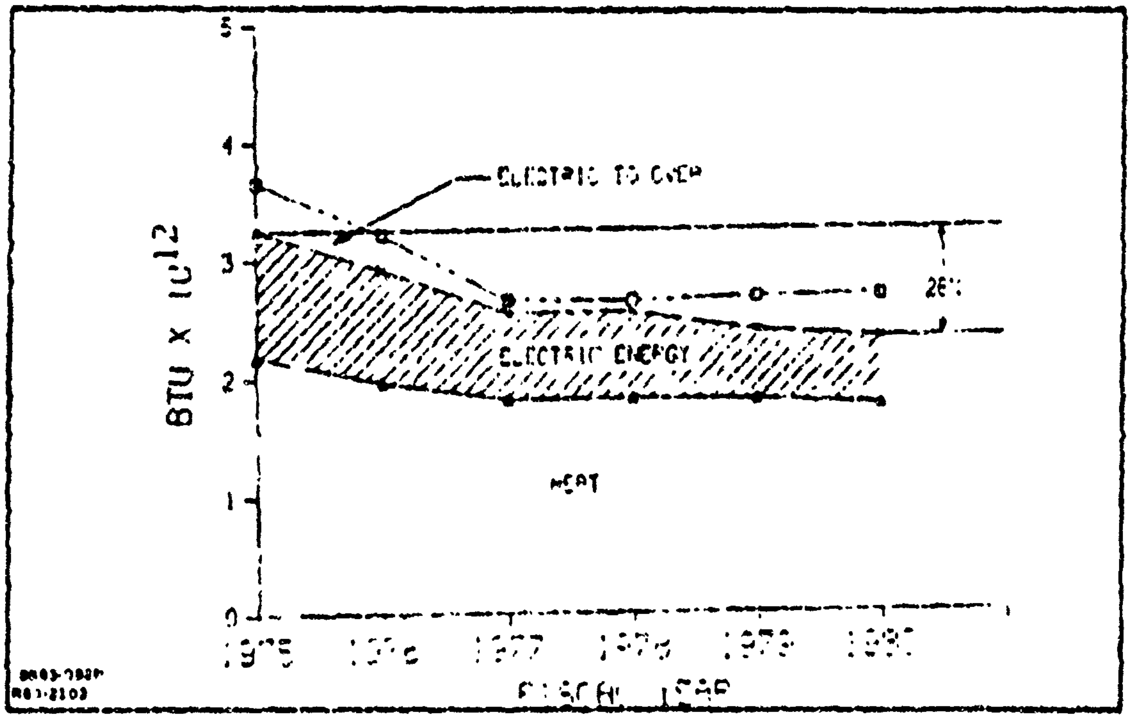


Fig. 2-1 Fort Wainwright Annual Energy Apportionment

electrical energy consumption along with the closing of the North Post Central Heating plant. Consequently, the percentage of non co-generated electricity produced at the marginal heat rate was reduced and the overall power plant efficiency was raised. A heat rate of 19,000 BTU/KWH is used here associated with the upper half of electrical power generation because heat is lost to the cooling pond. The lower half of electrical power generation is in a true cogeneration mode and is therefore most efficient. This stresses the importance of electrical energy conservation both at Fort Wainwright, and Fort Greely where the exported energy is consumed. The true cost of the upper portion of power generation should also be kept in mind relative to any plans to sell electric power from Fort Wainwright.

The large reduction in coal consumption from FY'75 to FY'77 is attributed to operational changes, primarily the reduction in exported electricity and the closing of the North Post central heating plant. Both actions served to significantly increase the cogeneration efficiency of the Central Heating and Power Plant (CH&PP). Other energy conservation actions were implemented in this period, but their effect is not readily traceable.

Since FY'78 a second downward trend in consumption is indicated that is attributed to the Energy Conservation Investment Program (ECIP) modifications implemented in this time period.

This energy history for Fort Wainwright is based on the monthly CH&PP Operating Account records, which appear to deflate the amount of coal apportioned to heating. These records reflect some discrepancies between coal consumption and metered steam and are used here only as approximations, in order to show trends. The heat balance study of the CH&PP showed that the accuracy of this record may be improved by more accurate condensate metering.

## 2.2 ENERGY USAGE ANALYSIS

A top-down analysis was made of FY'80 energy usage at Fort Wainwright. The apportionments are approximate due to practical limits of measurement accuracy and depth of analysis. Figure 2-2 shows an overall coal energy apportionment of 57% to heat and 43% to

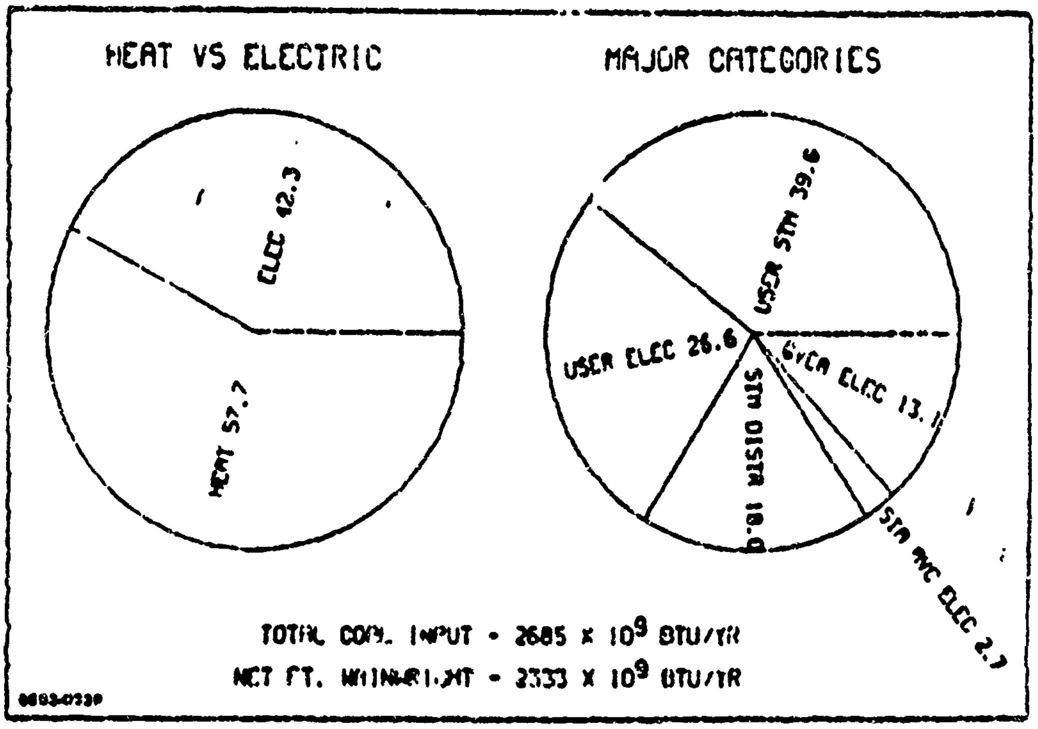


Fig. 2-2 Fort Wainwright FY'80 Source Energy Distribution

electric. Of this source energy, 66.3% is apportioned to end users at Fort Wainwright, 18% to steam distribution, 13% to exported electricity, and 2.7% to station service electrical. Cost apportionment is the same as source energy apportionment.

A site energy apportionment is shown in Fig. 2-3. This shows 45.3% of the energy consumed at the CH&PP. It indicates that an increase in plant efficiency would produce significant savings. User steam is 31.7%, user electric 8.8%, and all distribution is 14.6%. Heat loss reduction and electrical usage reduction are the focus of conservation in these areas. The 2.6% for exported electricity has an effect greater than this small number would indicate due to its impact on CH&PP efficiency. The importance of this is reflected in the 13% for exported electric (source basis) shown in Fig. 2-2.

Distribution of energy on a seasonal basis is shown in Fig. 2-4. This shows the low efficiency associated with summer operations. It

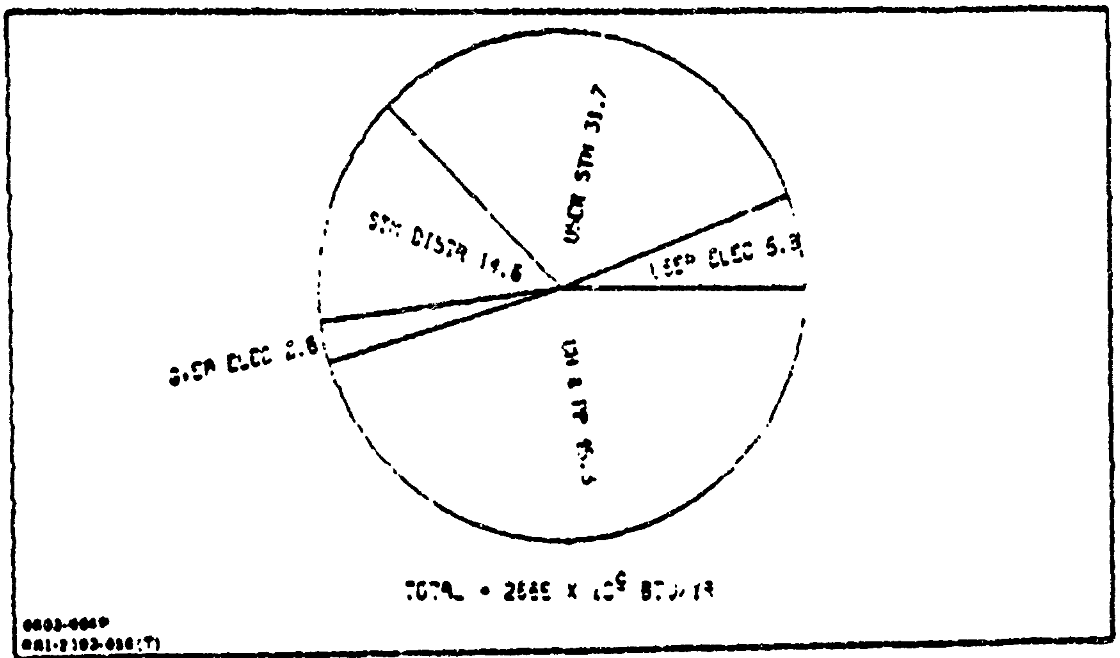


Fig. 2-3 Fort Wainwright FY'80 Site Energy Distribution

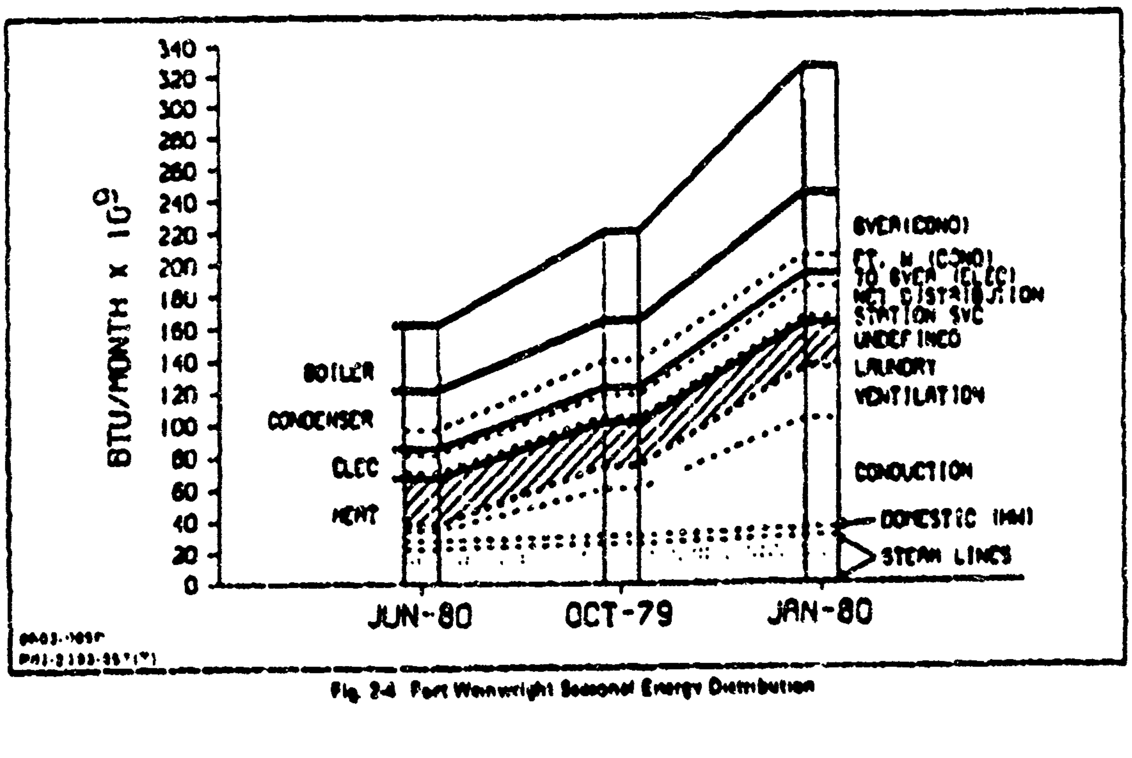


Fig. 2-4 Fort Wainwright Seasonal Energy Distribution

also shows the relative magnitude of boiler and condenser losses, fixed steam line losses, and an undefined area of user losses that have been largely attributed to excess infiltration from open windows and other leaks.

## 2.3 ENERGY PERFORMANCE

Facility and building energy performance is displayed on the energy index graph in Fig. 2-5. Electrical performance in KWH/GSF-yr is displayed separately from heating performance in KBTU/GSF-yr. This prevents the power plant efficiency variations from affecting comparison between user buildings and facilities. The diagonals in Fig. 2-5 represent reference lines of constant source energy if heating and electrical energy are combined. The electrical energy for the constant source reference lines is computed at 11,600 BTU/KWH, an average utility power plant heat rate for the United States.

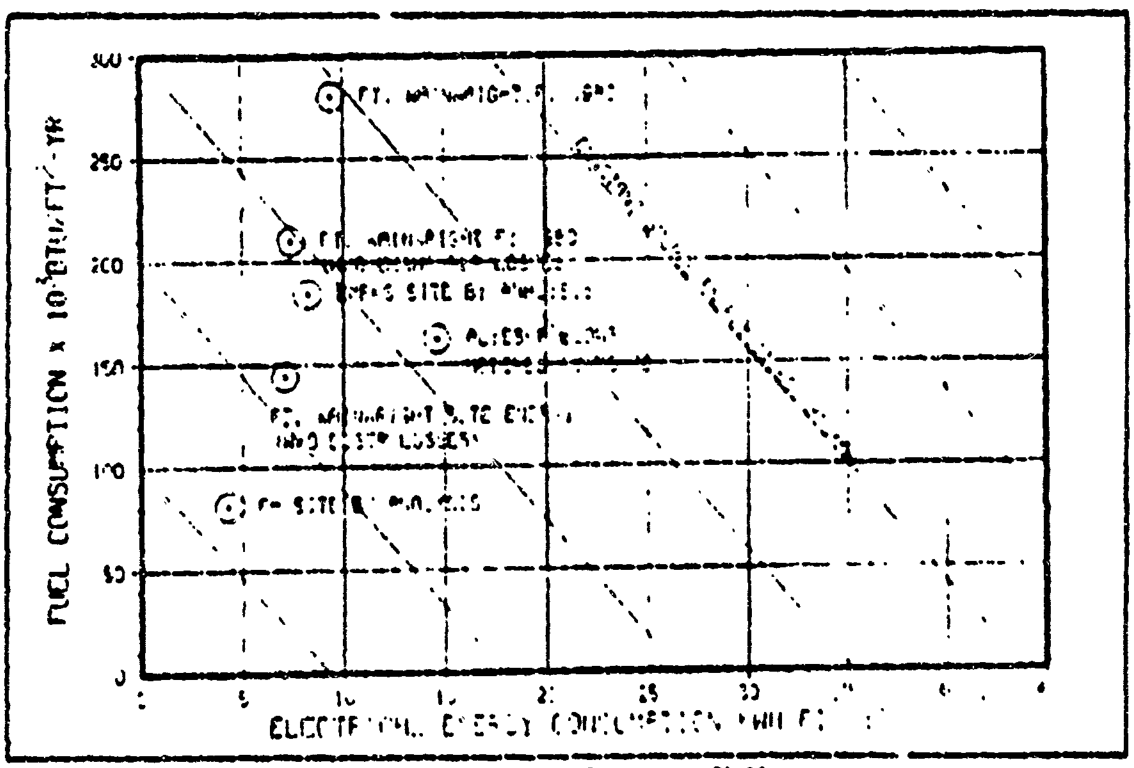

Fig. 2-5 Fort Wainwright Energy Index FY'80

The entire Fort Wainwright facility energy performance for FY'80 is shown at the top of Fig. 2-5. To arrive at a net building average performance index (Ft. Wainwright Site Energy on Fig. 2-5), boiler losses and steam distribution losses were factored out of the overall facility index. This calculated net building site demand index can be compared with actual metered site demand by buildings used by the Alyeska Project in FY'75. The net building site demand can also be compared with theoretical building site demand for a Family Housing (FH) unit and an Enlisted Person's Barracks (EMB) as derived by building analysis. The building samples approximated attainable target performance for at least 63% of the building area at Fort Wainwright. This target has not been achieved, due in large part to an inability to reduce building heat input to the level of building heat demand (based on conduction losses and ventilation requirements).

## Section 3
## RECOMMENDED ENERGY PLAN

The primary purpose of this study is to develop the recommended energy plan presented in the tables of this section. Also included are amplifying statements explaining each of the items in the plan. Section 4, which follows, shows the energy impact of this plan. Further discussion of the items can be found in the technical volume with detailed engineering analysis including cost and savings estimates in the appendix volume.

There are five tables used to present the plan, one for each Increment of Study, and one summary table. They are as follow:

- Table 3-1 presents Increment A Building/User ECIPs
- Table 3-2 presents Increment B Distribution System ECIPs
- Table 3-3 presents Increment F O&M Recommendations
- Table 3-4 presents Increment G Projects which do not meet ECIP criteria
- Table 3-5 summarizes the overall impact of the recommended plan.

There are differences between this final recommended plan and the project lists published in th final report draft of February 1981. Major differences are as follows:

- Lists have been categorized into Increments A, B, F, & G as per direction.
- Some projects have been consolidated into groups to fit Increment A ECIP criteria in accordance with established practice.
- Some projects have been revised as a result of additional information received during the Increment F and G study.

However, the appendix was not rewritten as a result of these revisions.

o New item numbers have been assigned to the projects of the final recommended plan. However, the W, WEC, and WECO designators from the draft report have been retained as reference numbers for traceability through the rest of this report, to the draft report and to the 1391 documentation and planning already underway in Alaska District.

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TABLE 3-1 FORT WAINWRIGHT INCREMENT A PROJECTS – BUILDINGS

| ITEM | ECIP PROJECT NO. | PROJECT | PROJECT LOCATION | FY'83 PROJECT COST ($ 000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$ 000) | SIMPLE PAYBACK PERIOD (YR) | FY'84 (1) ESTIMATED SAVINGS ($ 000) | NET FORT WAINWRIGHT SAVINGS ESTIMATE % FY'80 FUEL (2333 X 10⁹ BTU/YR) | TOTAL COAL SAVINGS % FY'80 (2665 X 10⁹) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | WEC 2, 3, 11 | Heating & Ventilation | Mass Dining Bldgs | 794 | 117,466 | 6.65 (2) | 223 | 1.9 | 415.2 | 7.61 | |
| 2 | WEC 8 | Lighting Conversion Incandescent to Fluorescent | Family Housing | 827 | 61,175 | 2.56 (3) | 74 | 5.2 | 143.1 | 2.62 | |
| 3 | WEC 5, 6, 7, 10, 12 | Lighting & Hood Exh Heating | Shop Bldg & Whole Post | 1,753 | 128,717 | 1.78 (2) to 2.65 (3) | 79 | 6.1 | 292.5 | 5.17 | |
| 4 | WEC 9, 14 | Basement Pipe & Wall Insulation | Family Housing | 2,336 | 99,750 | 1.48 (3) | 43 | 10.0 | 233.4 | 4.28 | |
| 5 | WEC 13 | Insulate Basement Walls and Concrete Floor Edges | EM & BOQ | 1,046 | 31,152 | 1.03 (3) | 30 | 14.3 | 72.9 | 1.34 | |
| | | Total & Averages | | 6,756 | 438,260 | 1.84 (2) to 2.67 (3) | 72 | 5.5 | 1,147.2 | 21.01 | 19.26 |

Fuel Costs

(1) Heating: Coal at $2.34/MBTU

Electric: @ 15,000 BTU/KWH

Remaining Benefits/Cost Factor

(2) 15 year Life = 10.380

(3) 25 year Life = 14.177

6003-001P

TABLE 3-2 FORT WAINWRIGHT INCREMENT B PROJECTS – DISTRIBUTION SYSTEM

| ITEM | ECIP PROJECT NO. | PROJECT | PROJECT LOCATION | FY'83 PROJECT COST ($ 000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/ INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$ 000) | SIMPLE PAYBACK PERIOD (YR) | FY'84[1] ESTIMATED SAVINGS ($ 000) | NET FT WAINWRIGHT SAVINGS ESTIMATE % FY'80 (2733 X 10^9) | TOTAL COAL SAVINGS % FY'80 (2869 X 10^9) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | WEC 9 10 | Trace Lines and Storage | Steam Distribution | 117.5 | 49,680 | 10.00[2] 14.78[3] | 423 | 1.0 | 116.2 | 2.13 | |
| 2 | WEC 4, 12 | Insulation of Flanges and Supply Line | Steam Distribution | 2,880 | 120,000 | 1.44[3] | 42 | 18.3 | 280.8 | 6.14 | |
| 3 | 1, 2, 3, 4 | Feed Water and Condensate System Modifications | CH & PP | 275 | 280,116 | 35.18[3] | 1,019 | 0.42 | 655.5 | 12.01 | |
| 4 | 5, 6, 7 | Boiler and Turbine Modifications | CH & PP | 1,038 | 120,080 | 2.87[2] | 111 | 3.83 | 383.3 | 6.10 | |
| | | Total & Average | | 4,358.5 | 570,000 | 2.85[2] to 4.30[3] | 121 | 3.52 | 1,237.8 | 22.67 | 19.78 |

Fuel Costs.

[1] Heating Cost @ $7.36/MBTU
Electric @ 12,000 BTU/KWH

Recurring Benefits/Cost Factor

[2] 15 year Life = 10.798

[3] 25 year Life = 14.777

6963-6007

TABLE 3-3 FORT WAINWRIGHT INCREMENT F PROJECTS – OPERATIONS & MAINTENANCE

| FCIP PROJECT NO. | PROJECT | PROJECT LOCATION | FY83 PROJECT COST ($ 000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/ INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$ 000) | SIMPLE PAYBACK PERIOD (YR) | FY84[1] ESTIMATED SAVINGS ($ 000) | NET ST [illegible] SAVINGS ESTIMATE % FY'80 (2333 x $10^9$) | TOTAL COAL SAVINGS % FY'80 (2635 x $10^9$) |
|---|---|---|---|---|---|---|---|---|---|---|
| INCREMENT A BUILDING | | | | | | | | | | |
| W 3 | Provide Low Pressure Steam For Main Laundry Appliances | Laundry, 3025 | < 30 | 2,770 | > 4 6[3] | > 130 | < 3 1 | 6 8 | 8 12 | |
| W 4 | Hot [illegible] Storage Tank | 2109 | NP | 5,937 | 6 1[3] | 118 | 3 6 | 13 9 | 0 25 | |
| W CO 1 | Fluorescent Lighting Improvement Program | | 150 3 | 26,410 | 6 08[3] | 1 76 | 2 43 | 61 8 | 1 13 | |
| W CO 11 | Swimming Pool | 3475 | 0 | 2,700 | NOT [illegible] | [illegible] | 0 | 6 3 | 0 12 | |
| W CO 9 | Ammo Storage Incandescent to Security Lights | 2293-7 | 51 | 2,330 | 0 57[2] | 46 | 8 4 | 6.4 | 0 10 | |
| W CO 2 | Insulation of Basement & [illegible] Room Pipe & Flanges | | | | 2 07[3] | | 7 44 | 78 | 0 51 | |
| | Total | | 471 | 92,130 | 3 83[3] | | 3.76 | 122 | 2 23 | 1 94 |

Fuel Costs

[1] Heating Coal @ $3 34/MBTU

Electric @ 12,000 BTU/KWH

Discounting Benefit/Cost Factor

[2] 15 year Life = 10 798

[3] 25 year Life 14 777

0093-000P

TABLE 3-5 WAINWRIGHT PLAN SUMMARY

| ECIP PROJECT | PROJECT | PROJECT LOCATION | FY'80 PROJECT COST ($ 000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/ INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$ 000) | SIMPLE PAYBACK PERIOD (YR) | FY'80[1] ESTIMATED SAVINGS ($ 000) | SAVINGS: NET FY WAINWRIGHT SAVINGS ESTIMATE % FY'80 ($333 X 10$^3$) | SAVINGS: TOTAL COAL SAVINGS % FY'80 ($585 X 10$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Increment A | | 4,716 | 450,700 | 1.84[2] to 2.52[3] | 73 | 5.9 | 1,147.2 | 21.01 | 18.78 |
| | B | | 6,358.5 | 529,003 | 3.07[2] to 4.20[3] | 171 | 3.57 | 1,237.8 | 22.67 | 19.70 |
| | F | | 471 | 92,132 | 3.83[3] | 111 | 3.9 | 122 | 2.23 | 1.94 |
| Total A, B, F | | | 11,545 | 1,071,375 | 2.35[2] to 3.21[3] | 93 | 4.6 | 2,507 | 45.92 | 38.50 |
| Duplicate B Items | G W/O [illegible] | | 8,460 ( 1000) | 394,700 (-121,000) | 1.62[3] | 47 | 3.1 | 922.4 (-783.3) | 16.97 (-5.15) | 14.50 (-4.51) |
| Total A, B, F, G W/O [illegible] or B Duplication | | | 18,050 | 1,344,455 | 1.80[2] to 2.46[3] | 71 | 6.0 | 3,146.1 | 57.63 | 50.07 |

[illegible]

(1) Heating Cost @ $3.34/MBTU

Electric @ 19,860 BTU/KWH

Remaining Benefits/Cost Factor

(2) 15 year Life - 10.750

(3) 25 year Life 14.777

[illegible]

TABLE 3-4 FORT WAINWRIGHT INCREMENT G PROJECTS – MISCELLANEOUS

| FCIP PROJECT NO. | PROJECT | PROJECT LOCATION | FY'82 PROJECT COST ($000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/ INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$000) | SIMPLE PAYBACK PERIOD (YR) | FY'84[1] ESTIMATED SAVINGS ($000) | NET FY WAINWRIGHT SAVINGS ESTIMATE % FY'80 (2333 X $10^8$) | TOTAL COAL SAVINGS % FY'80 (2568 X $10^8$) |
|---|---|---|---|---|---|---|---|---|---|---|
| Power Plant Topping Cycle | | CHP & PP | 8,400 | 394,208 | 1.62 | 47 | 9.1 | 927.4 | 13.20 | 14.68 |
| EMCS | | | 2,190 | 116,650 | 0.36*[3] | 53 | 4.5 | 373.0<br>(220)<br>153 | 5 | |

*Does not meet FCIP Criterion

Fuel Costs

[1] Heating Coal @ $2.34/MBTU

Electric @ 10,000 BTU/KWH

Recurring Benefits/Cost Factor:

[2] 15 year Life - 10.798

[3] 25 year Life - 14.737

0803 010P

TABLE 3.8 WAINWRIGHT PLAN SUMMARY

| ECIP PROJECT | PROJECT | PROJECT LOCATION | FY'83 PROJECT COST ($ 000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/ INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$ 000) | SIMPLE PAYBACK PERIOD (YR) | FY'84[1] ESTIMATED SAVINGS ($ 000) | SAVINGS: NET FT WAINWRIGHT SAVINGS ESTIMATE % FY'80 (2333 X 10[9]) | SAVINGS: TOTAL COAL SAVINGS % FY'80 (2603 X 10[9]) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Increment A | | 6,716 | 400,248 | 1.84[2] to 2.52[3] | 73 | 5.9 | 1,147.2 | 21.61 | 18.26 |
| | B | | 4,150.5 | 529,003 | 3.07[2] to 4.20[3] | 121 | 3.52 | 1,237.9 | 22.67 | 19.70 |
| | F | | 471 | 52,132 | 3.83[3] | 111 | 3.8 | 122 | 2.23 | 1.94 |
| Total A, B, F | | | 11,565 | 1,071,375 | 2.35[2] to 3.71[3] | 93 | 4.6 | 2,507 | 45.92 | 39.90 |
| | G W/O EMCS | | 8,400 | 394,300 | 1.62[3] | 47 | 9.1 | 977.4 | 16.90 | 14.60 |
| Duplicate B Items | | | (-1093) | (-121,880) | | | | (-283.3) | (-5.15) | (-4.51) |
| Total A, B, F, G W/O EMCS or B Duplicate | | | 18,850 | 2,344,995 | 1.80[2] to 2.40[3] | 71 | 6.0 | 3,146.1 | 57.63 | 50.07 |

Fuel Costs

(1) Heating Coal @ [illegible]

Electric @ 19,000 BTU/KWH

Discounting Benefit/Cost Factors

(2) 15 year Life - 10.738

(3) 25 year Life - 14.777

0393 01 1P

## Section 4

## ENERGY CONSERVATION CANDIDATE EVALUATION

Descriptions of the recommended energy conservation projects are discussed in the following subsections. They are divided into two categories, electrical and steam. The identifying project number is given with each project as a convenient cross reference to the tables and text of this report. W designates a Non-ECIP project for Fort Wainwright, WEC designates an ECIP candidate, and WECO designates an energy conservation opportunity not yet finalized or classified. A detailed analysis for each item is supplied in Appendices A and B. After completion of this work, an additional task on the Central Heating and Power Plant (CH&PP) was started. The preliminary work that interfaces with the CH&PP have been left in this section and the appropriate appendices. The results of the CH&PP study are discussed in Section 6.

Since many of these analyses were completed using FY'79 consumption figures, the percentages may not agree exactly in the final summary. The summary was computed using FY'80 consumption that was made available later in the program. The savings are listed in the summary as a percentage of the Fort Wainwright fuel. The savings are also shown as a percentage of the total fuel, which includes electrical energy delivered to the local utility.

Initial identified projects are shown on Tables 4-1 to 4-3. The savings are percentage of FY'80 fuel used by Fort Wainwright. Projects on Table 4-3 have been arranged differently in the [illegible] Summary. Project W-3 and W-4 have been kept in the none ECIP, Increment I category. W-1 has been made part of the CH&PP in the Increment E category. W-2 has been combined with WEC-1 from Table 4-1 and are now both a single Increment A item.

Table 4.1 Fort Wainwright ECIP Candidate Projects Summary – Increment A

| ECIP PROJECT NO | PROJECT | PROJECT LOCATION | FY83 PROJECT COST ($000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$000) | SIMPLE PAYBACK PERIOD (YEARS) | FY84 ESTIMATED SAVINGS ($000) | SAVINGS ESTIMATE % [illegible] 10^9 |
|---|---|---|---|---|---|---|---|---|---|
| WFC 2 | TIMERS-SETBACK H & V SYSTEMS | MAJOR MILITARY BLDGS | 690 | 125,739 | 7.91 | 218 | 1.4 | 294.3 | 5.40 |
| WFC 1 | TWO SPEED MOTOR CONVERSION H & V SYSTEMS | EMBS & 3015 | 144 | 34,061 | 5.98 | 236 | 1.8 | 79.7 | 1.46 |
| WFC 5 | LIGHTING CONVERSION INCANDESCENT TO FLUORESCENT | EMBS & COBS | 137 | 14,440 | 3.65 | 105 | 4.1 | 33.8 | 0.62 |
| WFC 6 | CONSOLIDATED LIGHTING IMPROVEMENTS | [illegible] | 181 | 14,870 | 2.87 | 82 | 5.7 | 34.7 | 0.64 |
| WFC 7 | HEAD BOLT HEATER ENERGY REDUCTION | PARKING | 70 | 44,860 | 5.54 | 719 | 1.95 | 105.8 | 1.82 |
| WFC 8 | LIGHTING CONVERSION INCANDESCENT TO FLUORESCENT | FAMILY HOUSING | 877 | 61,875 | 2.58 | 75 | 5.0 | 143.1 | 7.63 |
| WFC 9 | BASEMENT PIPING INSULATION | FAMILY HOUSING | 817 | 50,780 | 2.16 | 63 | 6.0 | 118.8 | 2.18 |
| WFC 10 | LIGHTING CONVERSION INCANDESCENT TO HPS | VARIOUS BUILDINGS | 522 | 25,450 | 1.89 | 49 | 8.8 | 59.6 | 1.09 |
| WFC 11 | CONTROL CONVERSION SETPOINT TO DEMAND H & V SYSTEMS | MAJOR MILITARY | 258 | 17,681 | 1.77 | 68 | 6.3 | 41.2 | 0.76 |
| WFC 13 | LIGHTING CONVERSION [illegible] EXTERIOR LIGHTING | WHOLE POST | 668 | 21,147 | 1.10 | 32 | 13.5 | 49.5 | 0.91 |
| WFC 14 | INSULATE BASEMENT WALLS | FAMILY HOUSING | 1,?20 | 48,980 | 1.11 | 26 | 13.3 | 114.6 | 2.10 |
| WFC 15 | INSULATE BASEMENT WALLS & CONCRETE FLOOR EDGES | EMB & BOQ | 1,046 | 31,352 | 1.03 | 32 | 14.3 | 77.9 | 1.34 |
| INCR A | TOTAL AND AVERAGES | | 6,718 | 490,708 | | 73 | 5.9 | 1147.2 | 21.01 |

[illegible]

Table 4.2 Fort Wainwright -- ECIP Candidate Projects Summary - Increment B

| EC PROJECT NO | PROJECT | PROJECT LOCATION | FY83 PROJECT COST ($000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/ INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$000) | SIMPLE PAYBACK PERIOD (YEARS) | FY84 ESTIMATED SAVINGS ($000) | SAVINGS ESTIMATE % OF FUEL 2333 X 10$^9$ |
|---|---|---|---|---|---|---|---|---|---|
| WFC 1 | STEAM TRACER AUTOMATIC SHUT OFF VALVES | STEAM DISTRIB SYSTEM | 118 | 41,500 | 9.5 | 378 | 1.1 | 97.3 | 1.79 |
| WFC 4 | INSULATION OF UNINSULATED STEAM LINES & FLANGES | STEAM DISTRIB SYSTEM | 180 | 20,000 | 3.89 | 111 | 3.9 | 46.8 | 0.86 |
| WFC 12 | REINSULATE STEAM SUPPLY PIPING | STEAM DISTRIB | 2,700 | 100,990 | 1.28 | 37 | 11.5 | 234.0 | 4.30 |
| INCR B | TOTAL AND AVERAGES | | 2,990 | [illegible]61,500 | | 54 | 7.9 | 378.1 | 6.95 |

[illegible]

Table 4-3 Fort Wainwright Non ECIP Candidate Projects Summary

| EC PROJECT NO | PROJECT | PROJECT LOCATION | FY'83 PROJECT COST ($ 000) | SOURCE ENERGY SAVINGS (MBTU/YR) | DISCOUNTED SAVINGS/ INVESTMENT RATIO | ENERGY/COST RATIO (MBTU/$ 000) | SIMPLE PAYBACK PERIOD (YEARS) | FY'84 ESTIMATED SAVINGS ($ 000) | SAVINGS ESTIMATE % OF FUEL 2373 x 10$^3$ |
|---|---|---|---|---|---|---|---|---|---|
| INCREMENT A BUILDINGS | | | | | | | | | |
| W 3 | PROVIDE LOW PRESSURE STEAM FOR MOST APPLICATIONS | LAUNDRY 3075 | 20 | 2,778 | 4.8 | 139 | 3.1 | 6.5 | 0.12 |
| W 4 | REINSULATE WATER TANK | 2100 | 50 | 5,932 | 4.1 | 119 | 3.6 | 13.9 | 0.25 |
| INCR A | TOTAL AND AVERAGES | | 70 | 8,702 | | 124 | 3.4 | 20.4 | 0.37 |
| INCREMENT B DISTRIBUTION SYSTEMS | | | | | | | | | |
| W 1 | LOWER STEAM DISTRIBUTION PRESSURE 90 TO 55 | CH & PP 3595 | 100 | 147,840 | 51 | 1478 | 0.3 | 345.9 | 6.35 |
| W 2 | ADD ELECTRIC SEWAGE PUMPS AT [illegible] EJECTORS | SEWAGE SYSTEM | 7.5 | 8,100 | 35.9 | 1080 | 0.4 | 18.9 | 0.35 |
| INCR B | TOTAL AND AVERAGES | | 107.5 | 155,940 | | 1450 | 0.3 | 364.8 | 6.70 |
| TOTAL NON ECIP PROJECTS | | | | | | | | | |
| NON ECIP | GRAND TOTAL/AVERAGES | | 177.5 | 164,642 | | 927 | 0.4 | 385.2 | 7.07 |

[illegible]

## Section 4
## BASEWIDE RECOMMENDED PROJECT

This section covers Increment A & B projects entered in the plan with the exception of the CH&PP Increment B projects covered in their own Section 5. Increment F & G discussion is in Section 6.

In this section, the groups are separated into electrical conservation projects, all of Increment A, and heating steam conservation projects of both Increments A & B.

### 4.1 ELECTRICAL ENERGY CONSERVATION PROJECTS

#### 4.1.1 General Discussion

The site visits and examinations of various buildings and facilities at Fort Wainwright have resulted in an assessment of electrical energy flows, utilization, and consumption.

Significant improvements are attainable in lighting systems and resistance heating (in the form of automotive engine block heating in winter). These improvements are typically generalized, due to the enormity of providing detailed installation designs for numerous locations and unique conditions. Motor loads have been identified and reported under Mechanical Systems and CH&PP Station Service as fan, pump, compressor, and other loads. As such, any fan or pump load reduction will automatically reflect a proportional reduction in the motor drive.

To assign a reasonable cost/KWH of energy, a thermodynamic balance and rate analysis was performed, based on energy reductions occurring at the marginal heat rate of 19,000 BTU/KWH of consumed coal without useful heat recovery. On this basis, we estimate 3¢/KWH (FY'79) to be reasonable. This is escalated at 10% annually as indexed to coal price forecasts. Estimates for installed costs were based on FY'79 rates, with annual 6% escalation to the year of construction.

Simple paybacks were computed on a basis of FY'83 installed cost and FY'84 as first year's savings.

### 4.1.2 Recommendations

Six recommendations for energy conservation are identified. All are categorized as Increment A items. Brief descriptions of these proposed projects are as follows:

- Lighting Improvement - Enlisted Men's Barracks (WEC-5)

  Incandescent lighting fixtures should be replaced with fluorescent fixtures in corridors, entries, toilets, and closets. Approximately 40 watts of fluorescent lamps will replace two 60-watt incandescent lamps.

- Consolidated Lighting Improvement - Hangar Facilities (WEC-6)

  The support areas of each hangar are typically illuminated with incandescent lamps and should be replaced with fluorescent fixtures. In this application, the evaluation is based on using a 40-watt fluorescent lamp to replace three 50-watt incandescent lamps.

  The hangar main floors generally utilize High Pressure Sodium (HPS) illumination. The lights were found to be on for 12 to 14 hr/day; much of the time this space was unoccupied. It is recommended that two-zone programmable controllers be installed to provide reductions of one-third to two-thirds total space illumination during periods of low occupancy.

- Head Bolt Heater (HBH) Energy Reduction (WEC-7)

  The average vehicle engine heater utilizes 600 watts and frequently plugs into uncontrolled or temperature switched receptacles, accounting for an estimated over 3-1/2 million KWH annual consumption at Fort Wainwright. This level can be reduced by almost 50% by using a power proportioning device at each receptacle cluster. It should be thermally sensitive, reducing through-put from 600 watts at -50°F to zero power at 10°F outside air temperature.

In addition it is recommended that Fort Wainwright:

- Promote the use of battery heat-pads and insulated covers to enhance cranking power
- Promote the need for properly tuned and winterized engines
- Investigate development of inexpensive automobile wind breaks or protection

o <u>Lighting Improvements to Family Housing</u> (WEC-8)

Family housing accounts for over 11 million KWH/year, or some 23% of the total Fort Wainwright electric consumption. The incandescent lighting consumption in the dining room, three bedrooms, and basement, which accounts for 4.23 million KWH/year, could be reduced significantly by use of fluorescent fixtures. The resulting savings of 3.25 million KWH offers attractive economic and E/C feasibility.

o <u>Conversion to HPS Lighting</u> (WEC-10)

Many shops, warehouses, utility buildings, plants, service facilities, and food services currently utilize incandescent lamps in open type luminaires. The incandescent lamps (with efficacy of 20 Lumens/watt) are relatively short-lived and frequently poorly maintained resulting in lighting levels of 10 to 20 foot-candles. Most such areas have ceiling heights in the 12 to 20 ft range.

A program of replacement with HPS low-glare, sealed luminaires, specifically suited for low bay installations, is recommended.

This type of installation will result in:

- Better lighting with 60-70% energy reduction
- Far longer lamp life
- Better system lumen depreciation due to dirt reduction and more favorable lamp characteristics.

- Exterior Lighting Improvements (WEC-13)

  Many of the outside lighting systems are incandescent or mercury vapor luminaires. Replacement and conversion to HPS lighting will reduce energy consumption by an estimated 60%, which will save 1.1 million KWH annually. This does not include any savings already realized by the ongoing Fort Wainwright E.C. program.

  To reduce initial cost, conversion of mercury vapor luminaires to HPS rather than replacement of the luminaires, is recommended. The existing fixture and ballast would remain intact. A conversion kit would include an HPS starter assembly, capacitors, new lamp, and possibly a socket extender.

### 4.1.3 Conclusions

The electrical savings covered here were derived from analysis of the best potential targets for energy conservation. These users consume 43% of the 48 million KWH consumed annually within Fort Wainwright. A savings of 10.4 million KWH is anticipated, or almost 22% of the total distributed electrical energy. When implemented, this total would be reduced to some 38 million KWH (assuming zero growth in facility or mission requirements).

The six reccommendations offered herein provide a major share of the attainable electrical consumption reductions. Virtually all of the buildings of Fort Wainwright offer some potential energy reduction through use of higher efficiency light sources and reduced or controllable "on-times".

## 4.2 HEATING STEAM ENERGY CONSERVATION PROJECTS

### 4.2.1 General Discussion

In the search for steam conservation, both distribution and users were surveyed. In the course of this survey, the CH&PP also became a subject ... study. Since the potential for savings there is significant, it is covered separately in Section 5.

In the study of the steam distribution system, it was found that there are savings opportunities in installation of additional insulation; installation of automatic controls for steam tracer lines; and replacement of steam by electricity for pumping sewage.

Most of the ECIP implementation effort accomplished to date has been in the user buildings. The two most significant accomplishments have been in installation of building insulation (including storm windows and doors) and in installation of heating controls (primarily on steam radiators and convectors). However, the full potential savings from the additional insulation have not been realized since the complex steam control problem (causing overheating) had not been fully solved.

#### 4.2.2 Recommendations

The recommendations for energy conservation in the steam area outside of the CHRPP are as follows:

##### 4.2.2.1 Increment A (Building) Items

- Timers/Night Shutdown H&V Systems (WEC-2)

  The ventilation provided by the Heating and Ventilation (H&V) system can be shut off at night. Automatic timers will provide the signal to do this function in the major military buildings. Electrical and heating savings will result.

- Two-Speed Motor Conversion, H&V System (WEC-3)

  The total air flow in most buildings is based on full load heating requirements. Much of the time there is zero or partial occupancy in many parts of the building. Variable or two levels of flow by motor speed control is recommended. This would result in electrical and heating savings.

- Basement Piping Insulation (WEC-9)

  The basements of the Family Housing units have many uninsulated heat sources. These consist of steam supply system equipment (in the mechanical equipment room), condensate

return lines, and domestic hot water lines. For the warmer half of the year this heat loss to the basement represents a net penalty. All these lines and components should be insulated.

- <u>Conversion of Setpoint Control to Demand - H&V</u> (WEC-11)

  Many heating and ventilating (H&V) units heat the supply air temperature to a set temperature, independent of what is required in the rooms. This contributes to overheating. It is recommended that the control logic be changed so that the supply air temperature responds to the demand of the room, thus decreasing heating energy. Details of this modification varies from using a typical room temperature, to using a mixed exhaust air temperature as the demand control point.

- <u>Insulate Basement Walls</u> (WEC-14)

  The well insulated Family Housing units lose almost half of their heat through the basement walls. It is recommended that these areas be insulated. Determination of the best method of insulation needs further evaluation in order to determine the most cost effective installation.

- <u>Insulate Basement Walls and Concrete Floor Edges</u> (WEC-15)

  The barracks lose about one quarter of their heat through the basement walls and from the concrete floor slabs to the external walls. The basement walls present the same problem as the WEC-14 project for Family Housing. These walls should be insulated in addition to the concrete floors. The floor to wall loss has several additional alternate insulating approaches. External insulation is preferred. Again, additional analysis is required in order to establish the most cost effective installation.

- <u>Provide Low Pressure Steam for Most Laundry Applications</u> (W-3)

  Much of the laundry heating requirements can be provided with lower pressure steam than the present 200 psig source. During

the survey, this possibility was verified by facilities personnel. Fixing the controls to the original configuration will allow for the dual use of high and low pressure steam. Energy savings result by extracting the low pressure steam from the turbines after the steam has contributed to the generation of electric power.

- Reinsulate Water Tank Near Building 2108 (W-4)

  The insulation on this water tank is wet, causing greatly increased heat loss. This problem was uncovered by the infrared pictures provided by facilities personnel. This tank should be reinsulated.

4.2.2.2 Increment B (Distribution System) Items

- Stem Tracer Automatic Shut-off Valves (WEC-1)

  Most of the three miles of steam tracer lines carry line steam all year to prevent water and sewage lines from freezing. For half the year the steam can be automatically shut off since their freeze protection service is not needed for above freezing conditions. Automatic fail safe temperature sensing valves are recommended for this shut-off function.

- Insulation of Uninsulated Steam Lines and Flanges (WEC-4)

  There is a small portion of the steam distribution system where there are uninsulated lines. In addition, many uninsulated flanges exist. These account for a disproportionate heat loss. It is recommended that these areas be insulated.

- Reinsulate Steam Supply Piping (WEC-12)

  In the steam distribution system, the high temperature steam supply lines represent most of the distribution system heat loss. These pipes are under insulated according to new Army standards. Justification of these new standards are confirmed by life cycle cost analysis. It is recommended that additional insulation be added to these supply lines. An analysis of

insulation methods, labor and fees, in order to determine least cost, is recommended.

- Add Electric Sewage Pumps at Ten Sewage Ejectors (W-2)

  Five sewage pump stations use steam to eject sewage from tanks by positive displacement. These pump stations thereby lift the sewage up to the next pipe for gravity flow to the final collection location. This pumping action with steam is very energy inefficient. It is recommended that small electric type sump pumps be added to the system, leaving the steam ejectors as a backup for unusual conditions.

4.2.3 Conclusions - Total Base Steam (Thermal Energy) Savings (Outside of CHAPP)

The coal savings anticipated by implementation of these steam conservation items is approximately 19% of the FY'80 Fort Wainwright consumption (without GVEA export).

## Section 5
## CENTRAL HEATING & POWER PLANT (CH&PP) ENERGY CONSERVATION

### 5.1 SUMMARY

A supplementary task to perform a CH&PP Energy Study of the Fort Wainwright CH&PP was added to a Basewide Energy Study of that Fort. The study objective was to identify changes required to achieve maximum plant efficiency based on heat balance studies. This section covers results of that supplementary task.

The CH&PP supplies Fort Wainwright with electrical power and heating steam currently distributed at 70 psig (reduced from 90 psig as an interim result of this study). It also supplies Fort Greely with power via a 90-mile utility tie line, and supplies power from excess generating capacity to the local utility.

Six active coal-fired boilers rated at 150,000 lb/hr are used to generate 400 psig team. Four active turbine generator sets are available to generate electrical power. Normal winter operation is with three boilers generating up to 300,000 lb/hr steam and with two turbine generators generating up to 12 MW power. The plant is operated efficiently within the constraints of the existing equipment and power requirements. However, physical changes can be made to increase the operating efficiency.

Turbine performance basically defines the plant's performance. Power generated by extraction steam distributed to the Fort is produced efficiently in a cogeneration mode at a heat rate of around 5,000 BTU/KWH. Power generated by condensing exhaust steam, however, is produced at a heat rate approaching 25,000 BTU/KWH, and represents a basic inefficiency because of heat lost to the cooling pond. Reduction of this loss is a primary objective.

There are two alternative paths to maximum efficiency in the CH&PP, assuming the long term continuation of the current plant power production requirements.

Alternative No. 1 - The most efficient alternative would be to install a topping cycle with a high pressure boiler generating steam for a 1,000 psig noncondensing turbine generator set of about 3 MW capacity that will exhaust into the existing 400 psig header in parallel with existing boilers. The remaining power requirements would be generated on existing turbine generator sets, with maximum extraction providing distribution steam to the Fort and minimum exhaust to the condensers and cooling pond. A preliminary estimate indicates this modification would cost about $8.4 million with a payback of nine years.

Alternative No. 2 - Assuming that Alternative No. 1 is not found acceptable for policy reasons, the existing plant can be made more efficient by an alternative set of modifications, most of which would not be cost effective if Alternative No. 1 were chosen. The major proposed modifications are as follows:

- Install variable speed flow control for ID/FD fans. These fans operate at an inefficient point on the fan curves and a large reduction in energy is feasible
- Install automatic boiler combustion controls
- Improve condenser performance by installing automatic tube cleaning systems in condensers, sharing condenser heat load between operating turbines, and increasing cooling water flow from pond to condensers.

In addition to either of the above alternatives, efficiency would also be gained by modifying turbine controls, thereby allowing a reduction in distribution pressure of heating steam to 50 psig. Converting the whole plant to high efficiency lighting, and modifying controls on the No. 1 turbine to allow simulaneous extraction at 50 psig and exhaust at 10 psig (to provide in-plant steam in winter) are further modifications to be considered.

There are additional minor modifications that may be made as mentioned in the report, but the savings are insignificant in comparison to the foregoing recommendations.

Total potential savings with the topping cycle would be approximately 25% of Fort Wainwright CH&PP total FY'80 coal consumption; total potential savings with Alternative No. 2 would be approximately 13%.

## 5.2 STUDY FINDINGS

Study of the CH&PP yielded the following findings:

- Almost half of the energy used at Fort Wainwright is consumed at the CH&PP. Therefore, that plant's operation is of prime interest for Fort energy conservation
- About half of the current power generation is cogenerated efficiently at about 5000 BTU/KWH. This includes most of the power required at Fort Wainwright
- The other half of the current power generation is from condensing turbines at about 19,000 BTU/KWH. This heat rate approaches 25,000 BTU/KWH when station energy is apportioned. This half includes all of the exported energy and a smaller increment of Fort Wainwright power
- Flow through the turbine generators defines most of the heat balance
- Energy to the cooling pond defines the basic plant inefficiency
- The plant is operated efficiently within the given physical constraints
- The steam cycle is efficient and leaves little opportunity for steam saving improvements
- Current operation of turbine inlet conditions higher than nameplate ratings is efficient and should be continued
- Current operation of turbine exhaust pressure higher than design point is inefficient and efforts to lower it should be expedited

## 5.3 STRATEGY FOR CH&PP EFFICIENCY IMPROVEMENTS

For the Fort Wainwright usage portion of the CH&PP energy production, two basic steps are recommended:

1) Lower distribution steam pressure from extraction turbines to 50 psig, and use No. 1 turbine exhaust steam at 10 psig for deaerator heater and hot process water treatment steam requirements. These actions will increase the amount of electricity cogenerated by usable steam.

2) Lower station service electrical power requirements by use of more efficient lighting and variable speed drive on ID/FD fans and possibly other motor drives.

Accomplishment of the two foregoing recommendations will almost balance Fort Wainwright steam and electrical requirements (optimum cogeneration) independent of outside requirements.

A problem arises with regard to energy conservation for that portion of power, above the Fort Wainwright requirements, that is exported from the fort and is generated very inefficiently. In the past, this power has nominally gone to Fort Greely. In the future, a substantial portion will be going to the public utility. The question arises as to how capital costs for energy conservation in this category could be paid for, since the current pricing policy only allows for charging differential fuel costs. Since this is a policy question, it will be left open and discussions will be based on potential coal savings from the technical aspects.

The primary inefficiency at the Fort Wainwright CH&PP arises from the heat wasted in the cooling pond. There are two possible approaches to a solution for this problem:

1) Minimize the cooling pond utilization by installing a properly sized topping cycle (high pressure steam, about 1000 psig, through turbines to 400 psig header, and then through existing turbines to distribution pressure). This will increase the electric generation from the required extraction steam to a level that almost eliminates condenser exhaust flow.

2) The alternative is to maximize efficiency of the present condenser/cooling pond operation by increasing condenser cooling circulating water flow; providing automatic cleaning for condenser water tubes so they can be cleaned daily; increasing heat exchanger effectiveness; and lowering the temperature of the cooling pond by spraying .

Either of the these approaches would have benefits for the small amount of power required by Fort Wainwright in excess of a balanced power-to-extraction ratio, and for the large amounts of power for Fort Greely and GVEA (all of which is generated at the high cost rate with condensing turbines).

## 5.4 RECOMMENDATIONS

The specific recommendations for increasing plant efficiency, presented here, are further discussed in the Technical Volume and Appendices E and F. Selection from among these recommendations must be made within the alternative strategies discussed in Subsection 5.3.

These recommendations include the following:

1) Lower extraction (distribution) steam pressure to 80 psig and modify turbine controls as necessary (it is understood that control hardware is on order). For any user requirements that are not met by the lowered steam pressure, provide an alternative solution. The large overall savings possible by this action will be compromised if small users dictate steam distribution pressure.

2) Use the No. 1 turbine for all 10 psig steam requirements with the rest of the No. 1 turbine on 80 psig extraction. It is necessary to correct control problems on this turbine to enable operation, since the turbine reportedly cannot be run with extraction and 10 psig exhaust at the same time. Also, provide accurate metering of 10 psig steam so that its flow can be controlled to match deaerator heater, hot process, and in-plant heating requirements.

3) Provide variable speed flow control for ID/FD fans. These fans are a prime user of station service power. Almost 50% of their current usage can be saved by variable speed control, since they operate most of the time in an efficient range of damper/vane control but must retain capacity for full load operation. An engineering optimization study is required to select from the available options. Variable frequency control is the recommended candidate.

4) Continue the program for conversion to high efficiency HPS lighting. It should be expanded to include a lighting engineering study to add switching capacity for non-safety lighting, and to supplement the changeover to high efficiency lighting by certifying that the proper light level requirements are being used rather than direct replacement of existing lighting on a fixture by fixture basis. Over 50% lighting energy reduction is possible.

5) Continue efficient operation of Boiler Feed Water pumping using the 125 hp pumps as in currently being done. Further study of these pumps is recommended to determine whether cost effective means to minimize throttling losses are available, such as additional smaller pumps or variable speed on one motor or turbine drive.

6) Miscellaneous pumps may offer opportunities for additional savings since normal operation of the plant uses one pump for each plant function operating over a wide range of flows. Therefore, we presume operation at low loads is inefficient and smaller step pumps may be indicated.

7) Continue improvements in metering, with emphasis on calibration and proper location of key meters. Stress accurate meter reading and log taking for the key meters. Use key meter information for monitoring and maintaining plant operation at peak efficiency.

8) Install automatic boiler combustion controls as was recommended by Black and Veatch. Use of $O_2$ and combustibles monitor as feedback control is recommended.

9) Use both condenser cooling circulating water pumps on operating turbines at all loads when condenser exhaust is above design pressure.

10) Investigate the potential for manifolding circulating water pumps so that off-duty pumps could be used to increase flow through operating condensers. An optimization study is required to determine the proper number of pumps for each operating condition.

11) Continue implementation of the project to enable use of well water for condenser cooling.

12) Install an automatic condenser water tube cleaning system in condensers for summer use. This will keep heat exchange to maximum effectiveness.

13) Install a feedwater heater to increase the flow of useable steam through the turbines.

14) In lieu of Items 3, and 8 through 12, install a high pressure topping cycle of about 3 MW capacity to eliminate pond losses. This system would require a sizing study after a policy decision on funding and long-range utility plans. It would cost about $8.4 million and have a nine year payback, based on preliminary estimates; it would also extend the life of the power plant.

## Section 6

## INCREMENT F&G RESULTS

The Increment F&G portion of this contract was formalized after submittal of the Basewide Studies Final Report Draft. One task remaining to be done at that point was to make recommendations relative to an open item energy conservation opportunities, "WECO," list published in the draft report. Those items where recommendations can be made have been incorporated in Section 4.2 and in this section, as appropriate, along with some other candidates identified in the course of Increment F&G studies.

### 6.1 INCREMENT G ITEMS

Two items are entered in the Increment G category as judged not to meet ECIP criteria. Brief descriptions of these items are as follows:

- <u>CHAPP Topping Cycle</u>

  This project has been described in Section 5, as a major result of the CHAPP study as Alternative No. 1. While the numerical ECIP criteria are satisfied by this project, it was judged to be outside the scope of a normal Fort Wainwright energy conservation project and so is entered here in Increment G.

- <u>Energy Monitoring Control System (EMCS)</u>

  A requirement for Increment B of this contract was to develop an EMCS System for Fort Wainwright to the Tri-Services NAVFAC Type Spec TS-13941-6. This project was evaluated and found not to meet ECIP criteria and so is listed as an Increment G project.

This EMCS project is not recommended for Fort Wainwright for the following reasons:

- Automatic energy conservation control modifications can be readily implemented with local control such as programmable controllers or smart clocks. These systems are simpler to maintain and would provide a significant part of the savings anticipated from an EMCS
- The state of the art for EMCS is presently undergoing significant changes. New government specifications are influencing the industry. Much trial by fire is being experienced in systems recently installed and expectations are not being realized. Problems in software, maintenance, instrumentation, and reliability abound
- The remoteness of the Fort and the inherent difficulties in obtaining replacement parts and prompt, good technical support must be considered
- The Honeywell AD 1000 System already installed can be expanded to cover useful E.C. functions at less cost

It is recognized that an EMCS could be a useful tool to a person trying to manage energy usage at Fort Wainwright, especially by providing useful management information. Installation of such a system would require formalization of the energy management and control function and training of operators to run the system. It is conceivable, but not apparent, that this activity could be an asset. We recommend that prerequisite to the initiation of a new EMCS should be the installation of an on site energy manager/controller who has determined, on a practical day to day basis, what can be and is to be controlled and whether a new EMCS would be of any use in his job of controlling energy. This study shows how to reduce energy usage by 46% without an EMCS. Further potential savings by an EMCS cannot justify the high costs of the new system. However, the energy management and control function

is legitimate and should be implemented by personnel rather than systems at this stage of development, with possible assistance of the AD 1000 system capability.

6.2 INCREMENT F ITEMS - O&M PROGRAM

A general opinion is that Increment F category E.C. Items falling within the Facilities Engineering budget have too much competition for funding and as a consequence will not get implemented. Therefore, where possible, such items have been consolidated into ECIPs to raise the potential for accomplishment. There are, however, things that can be done best on an ongoing basis under local control. The scope of these items cannot be totally defined or budgeted for, but guidelines can be set so problems can be identified and resolved when they are found. It is suggested such a local program can be successful with the provision of knowledge, manpower, and funding with accountability.

This report with its recommendations and especially its background technical discussion is a first step in providing some of the knowledge required, supplemented with E.C. training as it is available.

Further, in order to better implement the energy management function, it is recommended that dedicated funds be allocated for use by a small part of the Facilities Engineering organization where energy management and conservation would be a primary role, not diluted by other maintenance duties. Along with this function should be resources; authority to take action; and accountability for producing results in setting, obtaining and maintaining target energy reductions.

A reasonable starting budget for such a function would be about 2% of the energy budget. A dedicated energy conservation trained engineer is seen as a full time requirement to identify problems and appropriate solutions and direct corrective action with priority access to maintenance manpower required to take action. An implementation fund is also necessary. An estimated $50,000/year material budget with an engineer and the equivalent of two mechanics is

suggested as a starting point to explore this means to sustained energy cost savings.

Training in energy conservation is also seen as a necessary step for managers, supervisors and engineers and possibly selected mechanics. Unfortunately, useful training with an E.C. focus is not too widely available. There are too many diverse subjects that must be covered in some depths. In addition, each facility tends to have its own unique set of problems. Thus general courses don't always apply. On the job experience at solving these problems is probably the best supplement to available training.

Implementation of the recommended ECIPs are a necessary prerequisite to maximum E.C. at Fort Wainwright, however, the full potential cannot be realized from that alone. It needs the sustained O&M activity as well. There are some significant actions that can be taken even before the ECIPs are in place to attain a portion of the potential savings. Reading of the technical discussions on the various ECIPs will provide background knowledge and insight to supplement the following list of recommended Increment F, O&M actions.

- Fluorescent Lighting Improvement Program (WECO-1)

  Improvements recommended include relamping and reballasting with Power Saver alternates, when existing components require replacement due to failure. Group lamp replacement is also recommended over spot lamp replacement since it is more economical, maintains more even illumination, and permits a higher design Maintenance Factor (MF). Thus, 10-15% fewer lamps may frequently be installed while maintaining the same average illumination as compared to spot replacement. This is considered to be an O&M type program under Increment F type projects.

- Lamp On-Time Reduction (WECO-9)

  Excessive lamp on-time caused by lights-on during periods of building or area non-occupancy may be responsible for an appreciable amount of lighting energy. Voluntary manual ef-

forts to shut lights off appear to be effective at Fort Wainwright. However, there were conditions observed where lights were on when they didn't need to be. It is recommended that the on-site O&M activity include means to provide semi-automatic switching capability for areas where it would be appropriate.

Two types of semi-automatic switching systems have been used with significant success and reasonable payback. Both timed switches that require manual turn-on with automatic turn-off and clock activated controls where regular on times are in force can be effective.

o <u>Incandescent Lamp Reduction</u> (WECO-9)

It is recommended that an ongoing O&M program be established to replace incandescent bulbs with fluorescent fixtures whenever practical. Generally this implies bulbs that remain on for one or more shifts per day. One watt of fluorescent can replace 3 or 4 watts of incandescent for a significant overall electrical saving when the numerous locations are added up. This modification was recommended as an ECIP for Family Housing because it was possible to scope the job where the same conditions exist in many units. However in the military buildings the scope is difficult to assess because of the diversity of applications. Therefore it is best handled under on site control as an Increment F ongoing program.

One area where this action applies is in (6) Ammunition Stores buildings (2202-7) which utilize incandescent perimeter lighting that is switched manually by security guards to provide nighttime illumination for an estimated 4400 hours per year. Thirty 200-Watt luminaires per building sustain a total demand of 36 KW while consuming 158,400 KWH annually.

It is recommended that alternate luminaires be replaced with a 70 watt HPS outdoor type luminaire similar to the G.E. "Mini-mite" unit to provide general illumination on the (3) long sides of each building. The remaining incandescent fixtures would be manually operated only under emergency conditions and

thus meet the intent of the specification for the Ammunition area.

An annual savings of 122,300 KWH is anticipated, allowing a simple payback of 9.4 years from the first cost of $51,000.

o <u>High Efficiency Electric Apparatus</u>

It is recommended that replacement of failed electric apparatus be made using high efficiency equipment. Based on life cycle costing, the higher efficiency energy saving more than compensates for the premium price of such equipment. Specifically, replacement of motors, transformers and fluorescent ballasts should be done on this basis.

o <u>Thermostatic Valve Control</u> (WECO-3,4)

There were several unit heaters and radiators that did not have thermostatic valve control to shut off steam to these units. These all need thermostatic control to prevent overheating and energy waste during moderate weather.

It is recommended that the unit heaters have a steam line valve controlled in sequence with the thermostatically controlled fan. An override is required for freeze protection that will sense freeze conditions and maintain steam on the coil (Ogantz Valve). In a similar manner unit radiators in entry ways must have fail open valves, since there is a common problem of freeze up of these units in exposed locations.

o <u>Continuous Heating Control Program</u>

Once ECIPs are implemented or interim programs are accomplished there is an ongoing requirement to maintain controls in calibration and repair and to reset them as conditions change or they drift from the planned settings. It is recommended that this be done on a periodic basis. To illustrate, note the example of pins removed from a 7 day start-stop clock that left a fan motor running when it wasn't needed and for long periods of time. As long as a system is functioning, its control tends to remain untouched for years, whether it is wasting energy or not.

- **Steam Trap Maintenance**

Steam trap leakage is of continuous concern to energy conservation since it raises the temperature and thereby the continuous conduction loss of the condensate return system. It is, of course, of more importance in branches with no return. As an aid to steam trap maintenance it is recommended that color change, stick on patches (reversible wax type) be applied to all steam traps for immediate visual indication of trap leakage.

- **Piping Insulation** (WECO-2)

Piping, flange and valve insulation is covered by ECIP for the steam distribution (WEC 4,12) and family housing for basement pipes (WEC 9). However, past experience and site inspection has shown that such overall projects can be incomplete in their coverage. An increment F project is being added (WECO-2) to insulate basement pipes, flanges and valves in the SMB and many miscellaneous buildings. The insulation unit cost and savings are being estimated as 1/4 of that calculated for family housing (WEC 9). This is then a $200,000 cost savings of 12,000 MBTU and $28,000 per year. The actual savings can be higher due to the predominance of high temperature steam flanges without insulation, as evaluated in WEC 4.

Among the specific areas noted as having uninsulated piping (condensate, domestic hot water), flanges, and valve are:

| | | | |
|---|---|---|---|
| Gym | - 3452 | Hospital | - 4065 |
| Laundry | - 3025 | Barracks | - 3411, 3706 |
| BOQ | - 1045, 4062 | Misc Bldg | - 3707 |

This WECO-2 will cover the above buildings and a good part of the additional requirements. In addition, to cover further oversight contingency it is recommended that maintenance be given an ongoing task to upgrade missing, worn, damaged or deficient piping insulation as it is discovered in utilidors or buildings. The Facilities Engineer should be budgeted the

means to correct these deficiencies since the action has been demonstrated as cost effective for the ECIP.

- Domestic Hot Water Control Settings

  During the survey, some domestic hot water heater aquastats were observed to be set too high, even beyond the 140°F domestic upper limit specified for safety reasons. Generally 110°-120°F settings are adequate for washing purposes. Therefore that setting is recommended for hot water heaters except where there is a specific requirement for higher temperature, as may be found in mess kitchens. In the gymnasium, the water to showers was at a dangerously high temperature setting close to boiling.

- Interim H&V Program

  A major ECIP for Fort Wainwright is modifications to the H&V systems as discussed in Section 4.2. Some of the savings to be attained by this program could be made by the Facility Engineer in the interim while waiting for implementation of the ECIP. A dedicated team of an E.C. knowledgeable engineer directing the appropriate mechanics could probably accomplish this program with 1 to 2 man years of effort. The low cost items that should be done by this method are:

  - Reduce fan speeds by a sheave change. Since excess air flow is so generally the case, the exact amount of reduction is not critical, it could be whatever is practical. The fine tuning would come later after ECIP engineering is complete.

  - Calibrate controls of set point systems. Lower supply set points until occupants complain. Settings can be lower in summer than in winter. Raise mixed air set point to eliminate heating in moderate weather.

  - Where possible, move the set point control thermostat from supply duct to return duct. This will set the system up as a demand system where comfort and savings can be automatically maintained under varying load conditions.

The exact savings of this interim program is not predictable. However, the potential is large.

o <u>Swimming Pool E.C.</u> (WECO-11)

It is recommended that swimming pool temperatures, humidity and hours of fan operation be carefully set to minimize operating cost while maintaining comfort for the swimmers. This can be accomplished by setting conditions that limit the water evaporation rate from the pool surface and the swimmers skin. Specific recommendations are:

- Air humidity, 60% RH or preferable above
- Air temperature, 80°F or preferable above
- Water temperature, 80°F or perferably below
- Fan operation, limited to normal occupancy hours and off whenever pool is not to be occupied.

Pool operating costs are estimated at $6300/year operating at the numerical values given above. Cost could range from 1/3 to 4 times that value and remain within the pool design criteria envelope for pleasure swimming conditions. It is therefore important to understand the energy implications of pool operation and set controls accordingly.

o <u>Laundry</u> WECO-12

The laundry was found to be wasting considerable energy. Several of the possible operational modifications have now been partially implemented. Additional operational and hardware modifications are possible. Energy wastes were in three main categories.

- <u>Initial Conditions</u>

<u>Steam supply</u> - Too high pressure - all heat from 200 psig line

- Shut down not implemented

Users - Controls contributed to wasteful energy consumption

Heat Recovery - Dryer energy was exhausted without recovery. Waste water energy is recovered since unit was cleaned

- Recommendations

  Steam supply - Use the low pressure (100 psig) line for most of the building uses that will be throttled down to about 25 psig distribution lines

  - Minimize use of high pressure (200 psig) line to only the clothes presses

  - Shut down the high pressure line at the power plant for unoccupied periods

  - Insulate the M.E. room lines, flanges, valves. Also building condensate lines (WECO-2)

  Users - Repair steam leaks, traps, valves. Many now repaired

  - Change all Air Handling units (H&V and exhaust fans) to demand control for supply air and mixed air (WEC-11). Add time clocks for unoccupied shutdown (WEC-2)

  Heat Recovery - Use Corps of Engineers recommendations for the dryer heat recovery. See FESA-T-2087 (Mrs. Blanche Carpenter, Fort Belvoir, VA. 22060 - Phone A/V 354-5732)

o Hospital - WECO-13

Many storm windows and some inner windows were open in the hospital during all the on site visits. This included winter, spring and summer seasons. A detailed site study in November

together with study of building drawings indicated no need for open windows for most of the year. This building has less of the overheating causes than most of the Fort.

Maintenance should be directed to close the outside storm windows, and maintain them shut since they are difficult to operate.

Most radiator thermostatic valves functioned properly, but a few were open and overheating. The steam distribution and condensate return lines in the rooms were not contributing to an overheati:g problem. Therefore only valve repair is called for.

The heating and ventilating system does need modification and this is included in WEC-11. Supply air in many locations was uncomfortably hot, while other areas were comfortable. System control change are needed.

The basement had a great deal of waste heat released from pipes, flanges and valves which should be insulated. This is included in WECO-2.

- <u>Radiant Heat Floors</u>

At Fort Wainwright the glycol is pumped all summer, therefore wasting electric power. When the circulating pumps are stopped there is a build up of sludge in the pump area that clogs the system. By site visit and discussion at all three forts it is concluded that this has to do with the Fort Wainwright water chemical content. At both Forts Greely and Richardson, a similar problem does not occur during summer shutdown although they use the same antifreeze. The difference is the Fort Wainwright water which is alleged to have a higher iron content.

It is suggested the power plant treated water be evaluated for use in the radiant floor systems to allow summer shutdown. One building can be selected to demonstrate and if found acceptable extend to the other radiant floor buildings. The water treatment plant may soon have the well water preheated

by condenser energy. This will aid in removing calcium and thus possibly result in a favorable impact on the above sludge problem.

- <u>CH&PP Condenser Heat WECO-15</u>

  The condenser waste heat is presently being dissipated in the cooling pond. This is a waste of energy and is alleged to contribute to the winter ice fog problem for local driving. Consideration of utilizing this energy for local heating is being dropped at this time for several reasons. The CH&PP study resulted in many modifications that would decrease condenser energy if they are implemented. Another project will take well water, flow it through the condenser, recovering some of this waste energy, and then proceed to the Water Treatment building (3565) for final distribution to the fort. The preheated well water will then require less expensive water treatment. This preheated water will also have an indirect heating savings in the distribution system and buildings. Raising the water temperature 10°F to 15°F above the 38°F range will help remove calcium from this water. About 1.5% to 2% of total fort energy is needed. This can be provided by under 10% of the condenser water heat. This calcium removal may favorably impact the present Fort Wainwright sludge problem in the radiant floor heating system.

  After the above factors have been resolved, and if there still is a significant amount of condenser energy remaining, then local heating could be considered. The one application that looked practical was heating the Old Gym (3582). This building is close, connected by a utilidor, and nominally should be maintained at a low (50°F) temperature. This makes it a good application. Required heat exchanger equipment is high cost and the condition of the building presented some doubt on how many years the building will still be used. Therefore further evaluation was dropped.

## Section 7

## PROJECTED RESULTS FROM PROGRAM IMPLEMENTATION

### 7.1 ENERGY PERFORMANCE PROJECTIONS

If all recommended projects were implemented in FY'83, the estimated cost would be about $11.5 million and the first year savings in FY'84, about $2.5 million. The net Fort annual coal savings over FY'80 would be about 46% or 1,071 billion BTU/yr (42,855 standard tons of coal).

Figure 7-1 displays the projected profile of annual energy consumption at Fort Wainwright through FY'85, assuming successful implementation by FY'84 without topping cycle.

Figure 7-2 shows the projected energy performance improvement on an energy index chart.

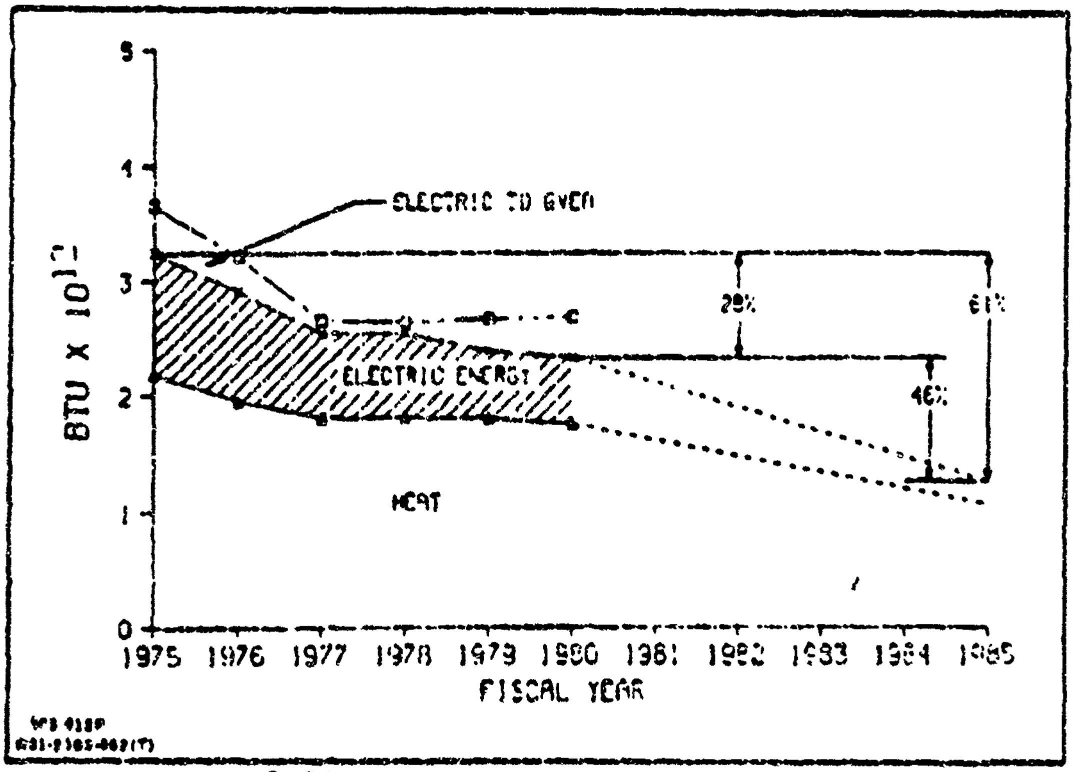


Fig. 7-1 Fort Wainwright Projected Annual Coal Usage

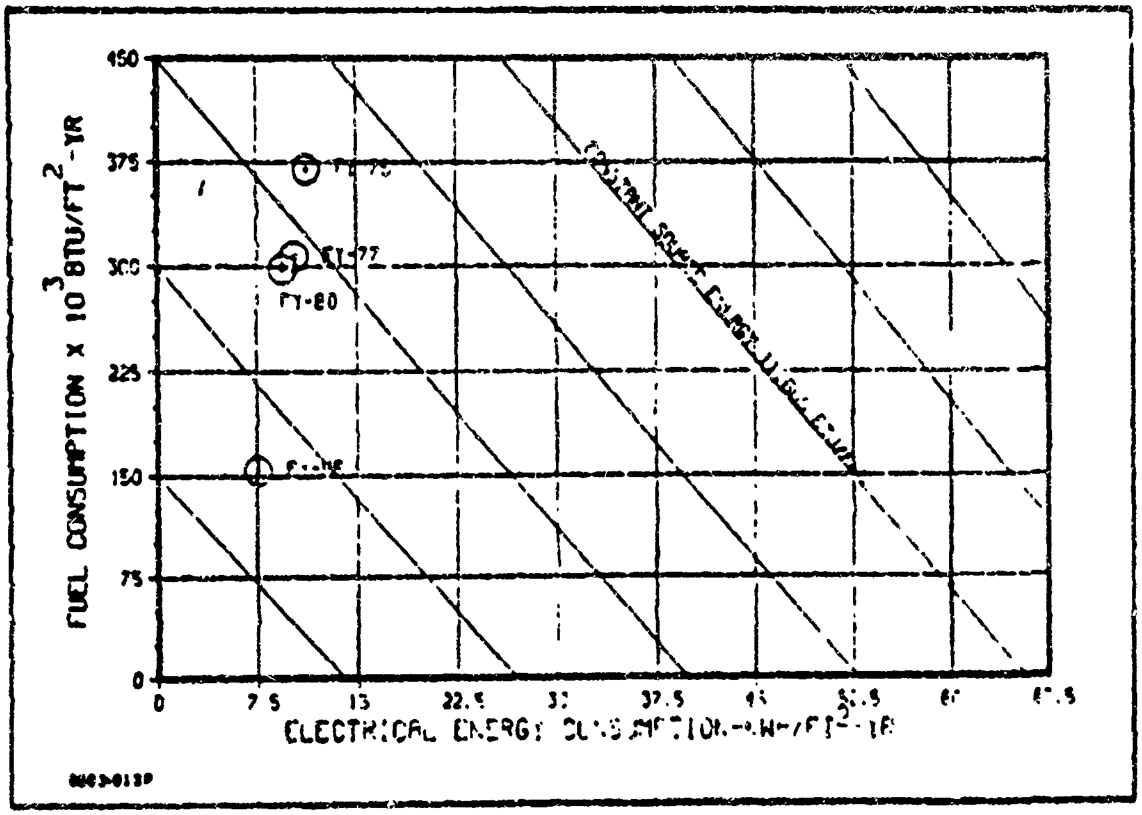


Fig. 7-2 Fort Wainwright Energy Index (FY'78 - FY'88 Projection

7.2 PRELIMINARY SCHEDULE

The recommended energy plan is a starting point for the evolution of an actual plan that will be implemented. Further engineering study may be desired before incorporation of low E/C ratio or long payback items. Feedback on the rate of funding availability, as well as technical and administrative review, and concurrence with this and subsequent studies, all enter into the plan evolution.

A simplifying assumption made in this study was that implementation costs were for FY'83 and first year savings were for FY'84. This allowed for ranking of projects on an equal basis, but is an unrealistic assumption for a plan. Time required for engineering and implementation, as well as annual funding limits, will tend to spread the implementation over a longer number of years. The tentative schedule is outlined in Fig. 7-3.

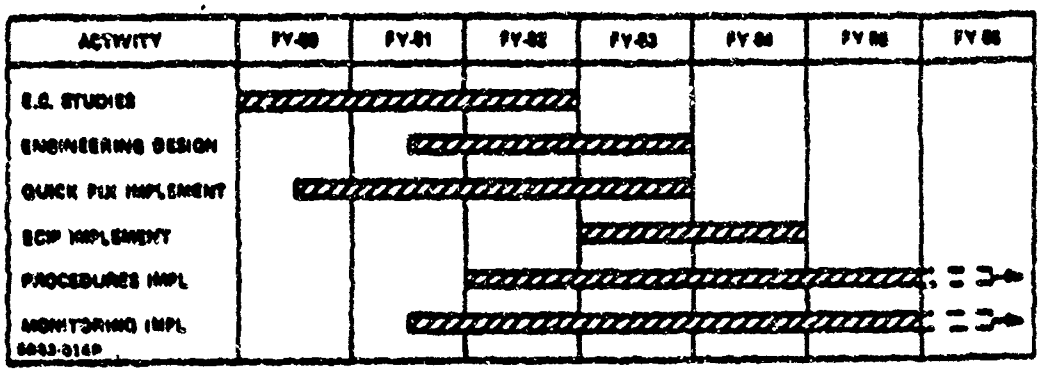


Fig. 7-3 Fort Wainwright EC Program Plan – Preliminary Schedule

This plan shows continuing study activity in FY'81, with possible start of quick fix implementation that will continue for several years. The ECIP implementation is spread over FY'83 and FY'84 with the prerequisite engineering time preceding it. This would provide a full first year saving in FY'85. Two other activities are shown as an essential part of an ongoing energy conservation program:

- Monitoring of energy consumption/savings on a continuous basis as a management feedback mechanism for spotting deficiencies
- Implementation of Increment F O&M procedures oriented towards improving and maintaining energy performance. Experience has shown that implementation of Energy Conservation Projects without a monitoring and maintenance program can lead to savings that tend to erode with time.

## 7.3 RELATIONSHIP TO ARMY ENERGY PLAN

This plan nominally meets the objectives of the Army Energy Plan of 8 August 1980. That plan sets objectives of a 20% energy reduction in facilities by FY'85 over FY'75. The measurements are to be in terms of BTU/GSF performance index. This goal has already been achieved with 28% savings at Fort Wainwright. The Army goal for the year 2000 is 40% of FY'75. This goal can be exceeded by FY'85 at Fort Wainwright by making over 61% savings with implementation of

this plan. The US Armed Forces Command (FORSCOM) performance target is 173,000 BTU/GSF-yr in FY'85. The projected Fort Wainwright performance will be 229,000 BTU/GSF-yr by FY'85. If allowance is made for the high degree day bias of Fort Wainwright, these indices are comparable. The use of petroleum fuels for facilities at Fort Wainwright is negligible. Therefore, the Army goal of 75% reduction is not applicable here. However, transfer of coal generated electricity to Fort Greely does help oil reduction at that facility.

To meet the overall Army goals, it should be recognized that some installations will have to exceed the 20% and 40% targets, because other facilitien will not be able to make such a large percentage gain since they might have been more efficient to start with. Therefore, maximum feasible savings should be the overall goal.